Vegetated Habitats

Functions and Values of Rockweeds:

What are Rockweeds?

Rockweeds are brown macroalgae such as *Ascophyllum spp.* and *Fucus spp*. Like kelps, they are primary producers converting inorganic nutrients into organic biomass by using the energy of the sun. They lack true roots, stems and leaves and because they lack a vascular system, absorb dissolved nutrients directly through the blades. The holdfast is used to attach the algae to intertidal rocks. Without attachment to hard substrates, algae will die. Unlike kelp, rockweeds have a higher light requirement, a higher water temperature tolerance (0 - 28°C), a higher tolerance to low salinity waters and, to some degree, can resist desiccation, ultraviolet radiation and overheating. Rockweeds can grow vegetatively or sexually. For *Fucus spp*. sexual reproduction can occur year-round while *Ascophyllum nodosum* reproduces in the late spring and early summer. In Maine, the life span of rockweeds ranges from approximately three years of age for *Fucus vesiculosus* to 16 years for *Ascophyllum nodosum* (Wippelhauser 1996). They grow slowly, therefore the recovery period for damaged or uprooted rockweeds can be decades.

Where are Rockweeds Located in Maine?

Rockweeds inhabit all intertidal zones with rocky substrates and seldom populate shallow subtidal habitats. They are the dominant algae in Maine, commonly found on rocky shores statewide. Rockweeds are located on sheltered and high energy ledge, boulder, and mixed course intertidal habitats. Small clumps can be found on sand flats or mud flats attached to rocks.

What are the Functions of Rockweeds?

Rockweeds are primary producers converting inorganic (e.g. phosphate and nitrate) nutrients into organic matter for grazers. They play an essential role in removing inorganic nutrients and trace metals and converting them into usable products for commercial and ecological use. By removing nutrients and metals (e.g. arsenic, copper, zinc) from the water column they help maintain water quality in bays, estuaries and rocky shores. Like eelgrass and kelp, portions of the algae break apart and are transported by

tides and currents to the nearshore forming large deposits of organic detritus. This detritus forms one of the bases of estuarine and marine food webs. The detritus formed from the dead algal matter is consumed by bacteria, and small marine invertebrates and insects which, in turn, feed birds, fish and mammals. Algal fragments also are carried offshore and feed the diverse subtidal benthos. Rockweed beds add structural complexity and surface area to rocky habitats. During low tides when the shores are exposed to air and direct sunlight, rockweeds provided protection to inhabitants from temperature fluctuations and desiccation. They provide shelter from predation and wave action, attachment sites for epiphytes and larvae, food resources for invertebrates and fish, feeding and nursery grounds for crustaceans (Wippelhauser 1996).

What are the Economic Values of Rockweeds?

Rockweeds have both indirect and direct commercial values in Maine. Approximately 4,000,000 - 7,000,000 pounds of rockweed are harvested annually in Maine (Fried 1999). Rockweeds are commercially harvested and sold as health food, nutritional supplements for humans and pets, fertilizer, agricultural products and packing material for lobsters. Rockweed is used as a stabilizer in food and cosmetics.

Indirectly, rockweeds support recreational and commercial fisheries by providing shelter for lobsters, foraging for juvenile fish, and food for herbivores, the prey of fish, waterfowl, and crustaceans. Juvenile pollock, in the summer feed during high tide on intertidal amphipods, periwinkles, mussels and isopods living on and within rockweed (Rangeley and Kramer 1995). Common periwinkles and sea urchins, worth $20 million at the dock in 1997, feed on rockweed in the shallow subtidal (NOAA 1997). Juvenile lobsters, supporting a fishery valued at over $138 million upon landing in 1997 (NOAA 1997), settle, forage and seek refuge in low intertidal rocky habitats covered in rockweed.

How Sensitive are Rockweeds to Disturbance and Development?

Rockweed habitats have been classified by DEP as moderately sensitive to disturbance and development in Maine (see Habitat Ranking). Even though they are ecologically and commercially essential habitats, they are widely distributed and have fewer functions and values than high sensitivity habitats. Due to their ability to resist the severe conditions of the exposed mid intertidal environment, the algae are less susceptible to disturbance.

What are the Threats to Rockweed Communities?

- Shading from physical structures: Shading blocks light and reduces growth.
- Removal and/ or disturbance of habitat: Dredging, filling, blasting of ledges, removal of boulders, impoundment of water, sediment loading and over-turning of rocks displaces, smothers or removes rockweed and its habitat.
- Resuspension of sediments: Resuspension of sediments from dredging, filling, boating and fishing activity smother rockweed.
- Pollution: Run-off of sediments and pollutants from upland construction sites, thermal discharges, industrial discharges, chlorinated effluent, oil pollution, stormwater run-off, sewage, airborne pesticides from agriculture and other activities all damage rockweed. In addition, phytoplankton blooms caused by nutrient loading from pollution cause reductions in light levels harming rockweed communities.

- Over-harvesting

How Should Rockweed Habitats be Managed?

- Avoid permitting activities that remove rockweed and rockweed habitat.
- Water dependent structures should be placed in areas that will not shade rockweed. If unavoidable, structures should be as narrow as possible, as high as possible and oriented as close to north-south as possible (see eelgrass for guidelines).
- Avoid sediment disposal on or around rockweed.
- If applicable, determine if current velocity, tidal flows or wave energy will be altered due to the proposed activity. If so, design the project to minimize physical changes.
- Discharges of freshwater or pollutants should be minimized around rockweed.
- New developments in the upland should maintain pre-development levels of ground water seepage and eliminate increases of stormwater runoff.

Summary of the Functions and Values of Rockweeds.

Functions	Values
1. Primary production	Food for invertebrates and fish Support commercial fisheries and wildlife Commercially harvested for food and nutrients
2. Three dimensional canopy structure	Create habitat in barren environments Refuge from predation, wave action, solar radiation, desiccation, weather, and temperature extremes Nursery for invertebrates and lobsters (low zones) Attachment site for larvae and eggs Increases biodiversity Supports commercial fisheries
3. Increases secondary production	Supports the food web Supports commercial fisheries
4. Nutrient and contaminant filtration	Improves water quality Supports commercial fisheries
5. Dampens current and wave energy	Reduces shoreline erosion Increases sedimentation
6. Oxygen production	Provides oxygen for marine organisms Improves water quality Supports commercial fisheries
7. Structure for the attachment of algae, diatoms and animals	Food resources for consumers Increases primary production Supports commercial fisheries
8. Production, accumulation and export of detritus	Fuels microbial, estuarine and offshore food webs Supports commercial fisheries
9. Recycling of nutrients	Supports plant and algal growth Supports commercial fisheries

Functions and Values of Eelgrass (*Zostera marina*)

What is Eelgrass?

Unlike algae, eelgrass is a vascular flowering plant with roots, stems and leaves. Eelgrass is an annual and perennial plant. The perennial spreads through sexual reproduction and asexual vegetative growth but the annual reproduces sexually (Keddy 1987). The annuals over winter as seeds (Robertson and Mann 1984). In some regions perennial plants function as annuals. Both annuals and perennials have equally valuable functions (Fred Short, personal communication, April 1998). The annuals produce a greater amount of flowers and seeds per unit area than the perennial plants (Keddy 1987). Eelgrass is intolerant of severe desiccation. Eelgrass tolerates a wide salinity and temperature range but is limited by light. Plant biomass is greatest in the summer months and decreases in winter. Ice scour uproots eelgrass in shallow intertidal regions in the winter (Wippelhauser 1996). Perennial beds can live for more than 10 years (Beal 1994).

Where is Eelgrass Located in Maine?

Eelgrass is located statewide in low intertidal and shallow subtidal mud flats, sand flats, and mixed course and fines environments in protected coves, bays, inlets and shallow tidal rivers. Eelgrass is limited by light availability but is known to survive to 35 feet deep (Wippelhauser 1996). Annual plants are located in eastern Maine.

What are the Functions of Eelgrass?

Eelgrass stabilize and bind substrates and absorb nutrients from sediments. They reduce water currents by frictional forces, dampen wave energy and slow erosional processes. They are primary producers removing inorganic nutrients from the sediments and the water column and through photosynthesis convert them into organic matter. The blades are food for grazing invertebrates, fish, American brant, Canada geese, black ducks and other waterfowl. The remaining dead plant matter adds substantial amounts of organic biomass to nearshore deposits of detritus and benthic habitats. The detritus fuels the microbial food web which, in turn, provides food for invertebrates, fish, and birds. Eelgrass beds add structural complexity and surface area to intertidal and subtidal

environments. Blades become covered in an organic felt composed of microscopic plants (benthic diatoms), bacteria and grazers. They provide shelter from predation and wave action; nursery grounds for clams, fish, blue mussels, sand shrimp, lobsters, crabs, and other aquatic organisms; attachment sites for epiphytes, snails and larvae; and shading from solar radiation. Shorebirds and commercially important fish species prey on worms and invertebrates living in and feeding on eelgrass. Species abundance and diversity is high compared to unvegetated sites (McRoy and Helfferich 1977; Short et al. 1993; Wippelhauser 1996)

What are the Economic Values of Eelgrass?

Eelgrass supports several commercial fisheries by providing structure, shelter, and foraging habitat in mud flats, mixed sediment or sand flat environments. American lobsters, blue mussels, soft-shell clams, razor clams, blood worms, sand worms, rock crabs, sand shrimp, periwinkles, and winter flounder all benefit from eelgrass beds. Eelgrass contributed to seafood landings in 1997 valued at over $153 million (NOAA 1997).

How Sensitive is Eelgrass to Disturbance and Development?

Eelgrass is a multi-functional productive habitat that has been classified by DEP as having a high sensitivity to disturbance and development (see Habitat Ranking).

What are the Threats to Eelgrass Communities?

- Shading from physical structures: Shading blocks light and reduces growth. Even temporary floats can smother and kill eelgrass beds.
- Removal and/ or disturbance of habitat: Dredging, filling, impoundment of water, sediment loading, and boating activity shades, smothers or removes eelgrass and its habitat.
- Resuspension of sediments: Resuspension of sediments from dredging, filling, boating and fishing activity shades and smothers eelgrass.
- Pollution: Run-off of sediments and pollutants from upland construction sites, freshwater discharges, nutrient rich groundwater, industrial discharges, chlorinated effluent, oil pollution, stormwater run-off, sewage, airborne pesticides from agriculture and others all damage eelgrass. Eutrophication from upland point and non-point source pollution stimulates phytoplankton and algal growth (epiphytes) reducing light levels reaching eelgrass beds.

How Should Eelgrass be Managed?

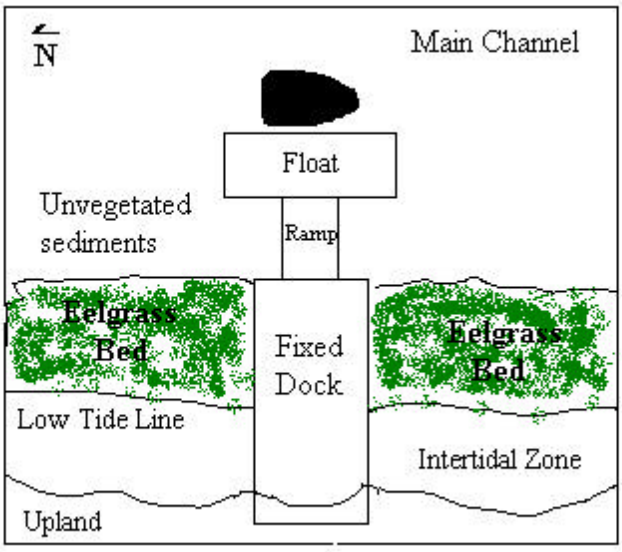
- Avoid permitting activities that remove, shade or smother eelgrass.
- Avoid sediment disposal on or around eelgrass.
- Minimize activity around eelgrass beds.
- Water dependent structures: structures should be place in areas that will not shade eelgrass in the winter or the summer. If unavoidable, structures should be as narrow as possible, as high as possible and oriented as close to north-south as possible (see guidelines below). Avoid permitting activities where boat traffic can shade or scour beds. Discourage the use of temporary or permanent floats. Encourage the use of

temporary pile driven piers with removable decking. Encourage the joint use of a public pier instead of the creation of a new structure.

- If applicable, determine if current velocity, tidal flows, shoreline contour, water clarity or wave energy will be altered due to the proposed activity. If so, design project to minimize physical changes. Compensate for the loss of eelgrass beds within the proposed site as well as impacted adjacent eelgrass habitats.
- Discharges of freshwater or pollutants should be minimized around eelgrass.
- New developments in the upland should maintain pre-development levels of ground water seepage and eliminate increases of storm water runoff.
- Transplanting eelgrass beds should be part of the mitigation plan when there are direct permanent losses of eelgrass habitats (see Fonseca et al. 1982; Short et al. 1999). Compensation for eelgrass losses is often required by the Environmental Protection Agency (EPA) in the ratio of 3:1 (replacement:loss). Mitigation must be completed and proven successful before development is permitted (Wippelhauser 1996).

Guidelines for Pier Design in or around Eelgrass Beds

To reduce impacts from shading, design plans should consider the height, the width, length, and orientation of the structure. The height of the dock and the orientation are the most important factors to reduce shading. Docks and piers should be at least 9 feet above the marine bottom. The best orientation to reduce shading is to place the structure within 10º of a north-south orientation. The narrower the structure the better. The piers should be less than 6.5 feet wide. Height needs to be added to the structure if it is oriented beyond 10º of N-S (0.7 feet should be added to the height requirement for every 10º increment). If a dock is wider than 6.5 ft, 1.3 feet needs to be added to the height (in addition to the 10 foot base), for every 3.3 feet of width. Docks should be long enough to extend to deep navigable waters unvegetated by eelgrass to prevent direct damage by boats. Larger boats should be moored off the dock and accessed by dingy. Temporary floats cause severe damage and should be avoided (see Burdick and Short 1999 and the Dock Design with the Environment in Mind CD Rom by Burdick and Short 1998 for additional guidelines).



Summary of the Functions and Values of Eelgrass (adapted from Short, F.T. et al. 1999).

Functions	Values
1. Three dimensional canopy structure	Complex habitat Refuge from predation, wave action, solar radiation Nursery area for invertebrates and fish Attachment site for larvae and eggs Supports commercial fisheries
2. Primary production and seed production	Food for invertebrates, fish, and waterfowl Supports commercial fisheries and wildlife
3. Increases secondary production	Support of the food web Supports commercial fisheries Supports shorebirds
4. Nutrient and contaminant filtration	Improves water quality Supports commercial fisheries
5. Sediment sink and trap	Improves water quality Increases area of benthic habitat Reduces coastal erosion Supports commercial fisheries
6. Dampens current and wave energy	Prevents erosion and resuspension of sediments Increases sedimentation
7. Oxygen production	Provides oxygen for marine organisms Improves water quality Supports commercial fisheries
8. Structure for the attachment of algae, diatoms and animals	Food resources for consumers Increases primary production Supports commercial fisheries
9. Production, accumulation and export of detritus	Fuels microbial, estuarine and offshore food webs Supports commercial fisheries Slows shoreline erosion
10. Recycling of nutrients	Supports plant and algal growth Supports commercial fisheries
11. Self-sustaining ecosystem	Encourages recreational and educational activities Landscape level biodiversity

Functions and Values of Kelp:

What is Kelp?

Kelps are brown algae that have one of the highest rates of primary productivity in the world (Lee 1992). The family of kelps in Maine include *Laminaria* spp., *Alaria* spp., *Agarum* spp., *Chorda* spp., and *Saccorhiza* spp. They differ from eelgrass because they lack true roots, stems and leaves. They absorb nutrients through the blades. Nutrients are transported to the stalk and holdfast. Kelps are intolerant of desiccation and restricted to low intertidal and subtidal environments (Wippelhauser 1996). The coastal kelps of Maine are cold water species. *Laminaria* spp. cannot successfully reproduce in water temperatures above 55°F (Lee 1992). Vegetative growth is greatest when concentrations of nutrients are optimal and light is available. Depending on the chemical and physical characteristics of a region, maximum growth occurs between late winter and summer. Ice scour limits growth in the winter months. The life span of some subtidal *Laminaria* is approximately three years whereas intertidal species are annuals (Wippelhauser 1996).

Where is Kelp Located in Maine?

Kelps live in low intertidal and shallow subtidal moderate to high wave energy environments. They attach to ledge, boulder, and mixed coarse environments on the mainland and off-shore islands of Maine. Depending on the species, water clarity, and predation pressure, some kelps can live at depths of 130 feet (Vadas and Steneck 1988). Unlike rockweed, kelp beds are not as common in Maine. Predation by sea urchin and other marine organisms periodically reduces kelp biomass. In addition, suitable wave and tidal energy, water clarity and subtidal geological features limit their distribution and growth.

What are the Functions of Kelp?

Kelp are primary producers converting inorganic nutrients into organic matter for secondary consumers. They play an essential role in removing inorganic nutrients (e.g. phosphate and nitrate) and converting them into usable products for commercial and ecological use. Like eelgrass, portions of the algae break apart and are transported by tides and currents to the nearshore forming large deposits of organic detritus. This detritus forms a base of estuarine and marine food webs. The kelp beds add structural complexity and surface area to an otherwise barren environment. They provide shelter from predation and wave action, attachment sites for epiphytes and larvae, food resources, and nursery grounds for fish, shellfish and lobsters, and protection from ultra violet radiation. The holdfasts offer unique microhabitats for brittle stars, scaleworms and other invertebrates. Species abundance and diversity is high in kelp beds compared to unvegetated sites. They are the main food resource for snails, amphipods, chitons, limpets, and urchins. The detritus formed from the dead algal matter is consumed by bacteria, small invertebrates and worms which, in turn, feed birds, fish and mammals. Large kelp beds reduce water currents by frictional forces and increase sedimentation (Wippelhauser 1996). Their presence reduces shoreline erosion.

What are the Economic Values of Kelp?

Adult kelps are harvested, processed and sold as health food, nutritional supplements and thickening and stabilizing agents in common household foods. Approximately 150,000 pounds of kelp are harvested annually by just two companies in eastern Maine. Much more is harvested in Maine but not reported to regulatory agencies. Blades are also collected for food for sea urchin aquaculture and packaging material for lobsters.

Kelps are consumed by commercial species and create habitat used by commercially valuable fish and invertebrates. Kelps are the most important food for green sea urchins. In 1997, sea urchin landings in Maine were valued at over $20 million. In addition to direct use, Atlantic cod and American lobsters forage and seek shelter in kelp beds and Atlantic herring deposit eggs on kelp fronds. Kelps were key supporters of seafood landed and valued at $150 million in 1997 (NOAA 1997).

How Sensitive are Kelps to Disturbance and Development?

Kelps are classified by DEP as a high sensitivity habitat (see Habitat Rankings). They are ecologically and commercially valuable, sensitive to disturbance and a limited resource in Maine.

What are the Threats to Kelp Communities?

- Shading from physical structures: Shading blocks light and reduces growth potential.
- Removal and/ or disturbance of habitat: Dredging, blasting of ledges, removal of boulders, impoundment of water, scouring by boat traffic, removal or dragging by fishers, and sediment loading smothers or removes kelp and its habitat.
- Pollution: Run-off of sediments and pollutants from upland construction sites, increases in freshwater discharge, industrial discharges, chlorinated effluent, oil pollution, stormwater run-off, sewage, airborne pesticides from agriculture and other

activites all damage kelp. In addition, phytoplankton blooms, caused by nutrient loading from pollution, cause reductions in light levels harming kelp beds.

- Resuspension of sediments: Resuspension of sediments from dredging, filling, boating and fishing activity smother kelp. Resuspension of sediments may resuspend larvae and small invertebrates changing the community structure of the habitat and endangering kelp beds.
- Over-harvesting

How Should Kelp be Managed?

- Avoid permitting any activities in kelp beds.
- Avoid permitting any activities that remove kelp and kelp habitat.
- Water dependent structures should be placed in areas that will not shade kelp or indirectly impact kelp beds. If unavoidable, structures should be as narrow as possible, as high as possible and oriented as close to north-south as possible (see eelgrass for guidelines). Avoid permitting activities where boat traffic can shade or scour beds.
- Survey areas for lobsters. Lobsters may concentrate in large kelp beds or use smaller patches for shelter.
- Avoid sediment disposal on or around kelp beds. Avoid activities that will resuspend sediments around kelp beds.
- If applicable, determine if current velocity, tidal flows, wave energy or water clarity will be altered due to the proposed activity. If so, design project to minimize physical changes.
- Discharges of freshwater or pollutants should be minimized around kelp beds.
- New developments in the upland should maintain pre-development levels of ground water seepage and eliminate increases of storm water runoff.

Summary of the Functions and Values of Kelp Beds.

Functions	Values
1. Primary production	Food for invertebrates and fish Support commercial fisheries and wildlife Commercial harvested for food and nutrients
2. Three dimensional canopy structure	Create habitat in barren environments Refuge from predation, wave action, solar radiation Nursery grounds for cod, shellfish and lobsters Attachment site for larvae and herring eggs Microhabitats of animals in holdfasts Supports commercial fisheries
3. Increases secondary production	Supports the food web Supports commercial fisheries
4. Nutrient and contaminant filtration	Improves water quality Supports commercial fisheries
5. Dampens current and wave energy	Reduces shoreline erosion Increases sedimentation
6. Oxygen production	Provides oxygen for marine organisms Improves water quality Supports commercial fisheries
7. Structure for the attachment of algae, diatoms and animals	Food resources for consumers Increases primary production Supports commercial fisheries
8. Production, accumulation and export of detritus	Fuels microbial, estuarine and offshore food webs Supports commercial fisheries
9. Recycling of nutrients	Supports plant and algal growth Supports commercial fisheries
10. Self-sustaining ecosystem	Increases biodiversity